

J A P A N · E C O N O M I C · I N S T I T U T E

JEI

R E P O R T

NO. 48A

December 20, 1985

U.S.-JAPAN TECHNOLOGY FLOWS: A TWO-WAY STREET?

Summary

In the eyes of many Americans, Japan is in the forefront of the current foreign challenge to U.S. technological leadership. Japanese and foreigners alike realize that this would not have been possible without significant imports of technology. Japan has drunk most deeply of all foreign countries from the fount of U.S. technology, perhaps increasing American concern over the Japanese challenge. Although the balance remains tipped in favor of technology imports, exports of Japanese technology have experienced rapid growth in the past few years, benefiting the United States, which absorbs the largest share. Despite this more even exchange, many Americans feel that the United States is not taking full advantage of Japanese technological developments. This report will review the history of U.S.-Japan technology flows and examine current efforts to develop a true two-way street.

Borrowing: A Japanese Tradition

Borrowing from abroad has been a constant theme in Japan's history. Early on, the Chinese writing system was adopted and adapted to the indigenous spoken language, just as Chinese civil administration became the model for Japan's feudal bureaucracy. Even in situations where Japan had developed its own technology, in metallurgy and ceramics for example, the borrowing and tailoring of foreign know-how was freely practiced.

Although Japan was ostensibly closed to foreign influence during the more than 200 years of the Tokugawa period, nearly half of all Japanese males

during this interlude received some sort of education, a development with important consequences for economic growth. By the close of the Tokugawa Shogunate in 1868, Japan's literacy rate rivaled those of the countries of Europe and the United States. Therefore, although isolation had frozen the existing level of technology at a low point in comparison to the West, Japan had the potential to close the gap rapidly.

This latent quality was fully expressed during the Meiji modernization drive. Foreign experts were hired to build railroads, shipyards, steel and textile mills. There were many false starts and failures among the multitude of attempts to borrow Western technology, but more importantly, Japan developed an awareness that it must not only actively control the inflow of technology, making the best or most appropriate choices, but it must also actively seek out these technologies from abroad. To this end, the Japanese government and the private sector began to construct an information-gathering network of global proportions.

Economic intelligence-gathering has always been practiced by embassy personnel abroad, but Tokyo's efforts were unusual because there was a direct link to commercial activities. Japanese firms could keep abreast of foreign developments through government sources and were often encouraged by Tokyo to adopt foreign technology. Many of the companies that introduced Western technology were at least partly funded or sponsored by the government.

These efforts paid off handsomely. By the turn of the century, Japan was able to abandon the "unequal treaties" it accepted during the early 1870s, and in 1905 it defeated Russia in combat for the rich resources of Manchuria -- ample evidence that Japan had developed an economic base sufficient to support a modern army and modern political institutions.

The borrowing continued apace throughout the years before World War II. A significant number of students were sent abroad for technical training and higher education. And although Japanese companies became more confident about striking technology deals, the government remained the driving force behind rapid technological change through 1945.

Technology Imports: Raw Fuel for Japanese Growth

The devastating effects of the Pacific war pushed Japan back to square one in terms of technology. The components for rapid growth, however, were again abundant. By the time Japan was able to satisfy its basic needs, the United States had forged ahead, creating a gap that made borrowed technology highly profitable for domestic firms. In addition, the education system was redrawn along Western lines thanks to the American occupation. Finally, Tokyo again played a key role in the technology transfer process, but this time through regulatory rather than direct means.

The results were, if anything, more impressive than the earlier effort. The inflow of technology in the form of licensing and joint venture agreements skyrocketed, according to Ministry of Finance data (see Tables 1 and 2). Under the new Ministry of International Trade and Industry, the technology selection

Table 1: Japan's Technology Imports, FY 1950-FY 1983

(number of approved cases and value in billions of yen)

	Cases		Value	
	Total	Of Which New:	Total	Of Which New:
FY 1950-55	1,148	n.a.	Y24.9	n.a.
FY 1960	588	n.a.	34.2	n.a.
FY 1965	958	n.a.	60.1	n.a.
FY 1970	1,768	n.a.	155.9	n.a.
FY 1975	6,766	796	169.1	Y13.3
FY 1976	6,050	632	177.3	17.9
FY 1977	6,659	685	190.1	16.9
FY 1978	6,573	936	192.1	38.2
FY 1979	7,012	1,020	241.0	26.8
FY 1980	7,248	919	239.5	27.7
FY 1981	7,207	844	259.6	24.9
FY 1982	6,936	929	282.6	44.4
FY 1983	7,839	1,073	279.3	42.4

Table 2: Japan's Technology Exports, FY 1950-FY 1983

(number of approved cases and value in billions of yen)

	Cases		Value	
	Total	Of Which New:	Total	Of Which New:
FY 1950-55	n.a.	n.a.	Y0.3	n.a.
FY 1960	n.a.	n.a.	0.8	n.a.
FY 1965	n.a.	n.a.	6.1	n.a.
FY 1970	861	n.a.	21.2	n.a.
FY 1975	2,811	1,073	66.6	Y18.9
FY 1976	2,767	735	83.4	27.0
FY 1977	2,880	897	93.3	36.3
FY 1978	3,157	1,063	122.0	47.1
FY 1979	3,667	1,087	133.1	52.1
FY 1980	4,103	1,237	159.6	74.3
FY 1981	4,877	2,017	175.1	70.8
FY 1982	4,738	1,970	184.9	63.3
FY 1983	6,403	2,494	240.9	74.9

Source: Prime Minister's Office, Report on the Survey of Research and Development

process became even more discriminating. Through a succession of economic outlooks called "industrial visions," MITI encouraged certain sectors and discouraged others. MITI was not omnipotent, nor were all its efforts successful, but the Japanese economy did gain access to key basic technologies that placed it in a good position to take advantage of the boom in international trade in the 1960s, the electronics revolution of the next decade and the current information explosion.

Most of the transfer agreements were voluntarily accepted by foreign firms, particularly American, because the Japanese did not seek state-of-the-art technology. Indeed, not only was older technology cheaper, but it was also more supportable in terms of the skilled labor and infrastructure required. Even this "hand-me-down" technology offered improved efficiencies compared to what was available after the war, translating into continued demand for foreign know-how.

As reconstruction advanced, however, Japan began to seek technology that was central to the emerging U.S. electronics industry. Particularly in the case of International Business Machines Corp., Tokyo conditioned the manufacture of advanced IBM products on the licensing of basic patents that would allow Japanese firms to develop IBM-compatible equipment. In other cases, the Ministries of International Trade and Industry and Finance cooperated by barring foreign companies from establishing wholly owned subsidiaries and arranging joint venture partnerships instead. Foreign firms were faced with being shut out of the Japanese market or gaining a presence in exchange for the transfer of technology. Many chose to accept the joint venture route, in part because it was usually of limited duration; the two partners were free to go their own way once the agreement expired. Surprisingly, MITI often had trouble winning the cooperation of the Japanese company, which was no more enamored of the forced marriage than the foreign firm. The joint venture between Texas Instruments Inc. and Sony Corp. is a good example -- MITI proposed the partnership when TI sought a foothold in Japan and controlled important patents (see Council Report No. 9, March 7, 1980).

These arranged partnerships became less and less frequent as Japanese firms built up a critical mass of research and development work. There was also a gradual shift of attitude toward less government interference in technology licensing because of this development, particularly after 1980. The levers used by MITI and MOF were also substantially weakened by the beginning of this decade, although the two still retain residual controls on technology flows.

How MITI and MOF Did It

An unusual set of circumstances combined to give MITI and MOF their very strong control over the flow of technology. The extensive war damage previously mentioned had one overriding consequence: it magnified the basic economic problem of how to meet a variety of needs with very limited resources. To meet this need, Tokyo intervened with extensive economic and financial controls. This position was accepted by a population that faced starvation and very high unemployment in the immediate postwar years.

In one sense, the government's task was easy -- almost any imported technology would yield a satisfactory return. On the other hand, it was

difficult to balance the needs of reconstruction with the imperative of defending the value of the yen under the Bretton Woods fixed exchange rate system. Tokyo was forced to put on the fiscal and monetary brakes when the overheated economy threatened several times to depress the value of the yen, inducing "recessions."

In addition, the task was complicated by disagreements between the government and private companies over what sectors should be developed. Government planners were no more prescient, and in some cases less so, than company presidents at picking winners and losers. The support they gave to shipbuilding, textiles and aluminum while at the same time discouraging the automotive and audio industries is an example of MITI's misjudgment. On the other hand, MITI did give the electronics and computer industries a boost.

In any case, the extreme demands on Japan's foreign exchange reserves during the reconstruction process led to the Foreign Exchange and Foreign Trade Control Law (Public Law No. 228), enacted December 1, 1949, and the companion Law Concerning Foreign Investment (Public Law No. 163) of May 10, 1950. By virtue of the fact that technology licenses have to be bought, and foreign investors often wish to repatriate profits, these two laws gave MOF and MITI the power to regulate most forms of technology transfers.

Foreign Exchange and Foreign Trade Control Law - In order to conserve the nation's scarce foreign reserves, MOF developed a set of rules covering financial flows into and out of the country. Controls on inward flows were meant to prevent private companies from over-committing themselves, but also to insure that only "proper" transactions were made. Although the law itself did not explicitly mention technology licensing agreements, it covered all foreign transactions, including services trade (Article 27). To wit, Article 42 stated, "Unless authorized as provided for by Cabinet Order, no person shall contract for services involving payment, settlement or any other transaction governed by the provisions of this law." Pursuant to this, Article 17 of the Cabinet Order Concerning the Control of Foreign Exchange (No. 203, June 27, 1950) was amended in 1963 to require residents and non-residents to obtain a license for services contracts, including those covering "technological assistance."

The implementing ministerial ordinance (No. 50 of 1950) was not wholly satisfactory because it was too vague for all parties concerned. Private companies were not sure how to structure proposals to meet MOF requirements, nor were MOF personnel sure of the impact of particular contract provisions. Foreigners were certainly mystified by the process and unhappy with the strict exchange control requirements.

Because of these problems, two new ordinances were issued: Concerning Control of Invisible Trade Transactions Relating to Foreign Trade (MITI Ordinance No. 49, April 1, 1963); and Concerning Control of Invisible Trade Transactions (MOF Ordinance No. 58, November 2, 1963). The first provided a relatively simple form for the technology importer, and the latter established clearer guidelines as to what kind of MOF approval was needed under the circumstances. The Finance Ministry order also established a list of "designated" technologies considered particularly desirable that would be handled expeditiously. At that time, this list covered technologies dealing with nuclear energy, aircraft, space development, computers and petrochemicals.

Although these laws would seem to be adequately comprehensive, MOF felt early on that inward foreign direct investment represented a special case. Therefore, a subsidiary law was drawn up that included even more specific regulations to promote and regulate technology flows.

Law Concerning Foreign Investment - Technological assistance, according to the law, covered the transfer of patents or utility model rights or technologies and license agreements thereof; technical assistance in factory management; and technical assistance concerning the management of enterprises or workshops in a wide range of industries. Until 1964 the provisions of this law came into effect when the payment period stipulated in the contract was one year or more (A-class contracts). Contracts for payment in less than one year (B-class contracts) were governed by the Foreign Exchange Control Law. Many foreign firms preferred the longer period because the foreign investment law had more lenient repatriation provisions. This distinction was eliminated in 1964 when Japan adopted Article 8 of the International Monetary Fund guidelines. Subsequently, all technological assistance contracts have been governed by the foreign investment law (except in cases where no desire to remit payment exists, in which case no regulations are applicable).

In brief, the law required that all technology transfers be validated by the Minister of Finance and any other appropriate minister (Articles 7, 8 and 10). The guidelines for approval were quite broad. Contracts that improved the nation's balance of payments, developed essential industries, or were essential for the continuation of earlier contracts were to be approved. On the other hand, if the contracts were "unfair," illegal, could have an adverse effect on the rehabilitation of the Japanese economy, or negatively affect Japan's foreign exchange situation, they could be denied. MOF and other ministries clearly had a great deal of latitude in screening technology agreements. While the law stipulated that the appropriate ministries had to respond within 30 days after receiving a request for validation, it was possible to ask for an extension. The ministries were not required to explain why a request was or was not approved. There was an appeal process, but it did not assure transparency or objectivity.

Both the foreign exchange control law and the foreign investment law contained reporting requirements for residents and non-residents alike. MOF had to be notified of a technology transfer deal before a validation request was submitted and after it had been consummated. Any alterations or renewals were also to be logged with the ministry. In an effort to ease this requirement, MOF and MITI permitted the Bank of Japan to act as their agent for many clerical tasks. The process remained relatively complicated and mysterious, however.

The application of the regulations varied in severity over the years. On occasion, the atmosphere was relatively open. At other times, ministries were openly hostile to certain types of contracts. This uncertainty sometimes played into the hands of Japanese companies -- just the threat of government interference was enough to push some foreign firms into joint ventures or licensing contracts.

Upon joining the Organization for Economic Cooperation and Development in 1964, Japan was obliged to liberalize controls on capital flows. Tokyo's

pace of liberalization was slow but steady, and by 1976 foreign direct investment in all but four industries would, in theory, receive automatic approval. Although this also applied to technology assistance contracts, MITI maintained a close watch on the flow of know-how.

The Present Regulatory Situation

When full compliance with the OECD's guidelines on capital transactions was achieved in 1980, MOF supposedly lost its powerful foreign exchange controls and MITI eased the foreign direct investment regulations. Although the levers still exist on paper, they are only supposed to be used under extraordinary circumstances.

A November 20, 1980 ordinance originating from every ministry, including the Prime Minister's Office, effected these major changes. It should be made clear that the framework for technology transfers has not changed -- the reporting and validation requirements are still in effect, mainly for data collection purposes. What has changed is the speed with which ministries must approve requests (one day to two weeks, depending on the number of ministries involved and the type of application) and the controls on payments, which have been eliminated. In support of this umbrella ordinance, MITI and MOF have also issued separate regulations to amend earlier directives as necessary.

Going even further, the government announced in June 1985 that practically all foreign direct investment applications, including technology-related contracts, will be immediately approved. The ministries involved in an application can ask for a short period of time to consider important contracts, but this should be an infrequent occurrence.

Patents and Other Forms of Transfers

The purpose of patents and utility models (actual working models embodying patentable inventions) is two-fold: to protect the interests of the inventor while allowing others to study and learn from the invention. Japan's patent system was modeled after this country's, and remains in essentially its original form today. The spirit of the Japanese patent process, however, is somewhat different than what the American occupation may have intended. As is generally the case in Asia, the Japanese have a very different view of industrial intellectual property. Although it is somewhat of an exaggeration, copying is still considered a form of flattery. Protections for industrial intellectual property have been traditionally weak in Japan, despite its participation in the Paris Convention on Industrial Property and the World Intellectual Property Organization.

Surprisingly, Japanese companies have developed the practice of patenting everything they can -- a reflection of intensely competitive home markets. In fact, they have extended this practice abroad. Tables 3 and 4 present data from the Japanese and U.S. patent offices on the overall number of patents granted, as well as the number granted to the other's nationals. It is obvious that there is a great deal of technology transfer taking place via patents -- activity that is rapidly accelerating.

Government-sponsored exchanges of researchers and joint research projects are a small but not insignificant conduit for technology exchange.

Until recently, it is safe to say that Japan and other countries got the most benefit from such exchanges. As evidenced by a number of Defense Department trips and public conferences in Japan, however, Tokyo now has a number of interesting technologies to offer.

Table 3: U.S. Patents Applied For and Granted, 1978-83

(cases)

	Applications		Granted	
	Total	By Japan	Total	To Japan
1978	109,300	10,400	70,500	7,100
1979	106,900	11,100	52,400	5,800
1980	113,000	13,100	66,200	6,600
1981	114,500	14,400	71,000	8,500
1982	118,400	17,300	63,300	8,800
1983	112,400	15,700	62,000	8,600

Source: U.S. Patent Office

Table 4: Japanese Patents Applied For and Granted, FY 1978-FY 1983

(cases)

	Applications		Granted	
	Total	By the U.S.	Total	To the U.S.
FY 1978	166,100	10,300	45,500	4,000
FY 1979	174,600	9,900	44,100	4,600
FY 1980	191,000	10,400	46,100	4,000
FY 1981	218,300	12,000	50,900	4,500
FY 1982	237,500	14,200	50,600	4,100
FY 1983	255,000	16,000	54,700	4,200

Source: Japanese Patent Agency

Commercial efforts to obtain foreign technology have grown in sophistication and variety. While efforts once were limited to intelligence gathering, licensing negotiation, and perhaps assigning personnel to study abroad, companies now invest directly in firms with promising technologies, sponsor research at foreign institutions and establish research centers staffed by foreign and domestic scientists.

Perceptions of Problems

As Japan and the United States find themselves locked in technological combat across a wider and wider range of industries, dissatisfaction with each

other's attempts to control technology flows has developed. For Japan, the biggest obstacle is the Reagan administration's national security fixation. Trying to insure that U.S. technology does not benefit our enemies has always been a concern, but only since 1980 has the Defense Department been able to implement tighter controls. Japan has often felt itself the target of DOD's censorship, although this is unlikely. By closing scientific conferences to foreigners, the Pentagon seems to be intent on keeping information out of the hands of allies and enemies alike.

Unfortunately, the U.S. list of complaints is much longer than Japan's.

- Residual regulatory controls have been the focus of U.S. attacks for some time. The argument is made that even simple reporting requirements act as nontariff barriers.

- The Japanese patent process also comes in for some licks. The fact that it can take a number of years for a patent to be approved, during which time competitors can examine and learn from the application, has been a major disincentive to foreign firms seeking to introduce their latest technology in Japan.

- In stark contrast to the U.S. scientific community, there is a profound lack of scientific publishing in Japan. Much of the research done within private firms is never disseminated or discussed. Not only does this lead to duplication of effort among Japanese companies, but it produces a less open situation than Japanese companies enjoy abroad.

- While Japanese firms can freely sponsor research at U.S. universities and research institutes, the same is not true in Japan. Indeed, it is even difficult for Japanese firms to fund research at a Japanese university. The blame must rest equally on government regulations covering such activities and on the closed nature of Japan's universities.

- Again, in contrast to this country, foreign firms have difficulty investing in Japanese companies that have promising technologies. Over the past several years Japanese companies have set up offices in American high technology havens, such as California's Silicon Valley and Massachusetts' Route 128 corridor, both to collect information and locate attractive investment opportunities. The barriers to such activities in Japan are institutional and cultural. Investment information sources are not well developed in Japan, reflecting the difficulties of arranging friendly participation in Japanese companies.

- National defense concerns also hinder U.S. access to Japanese technology, but in a rather upside-down way. Because of provisions in Japan's constitution banning offensive weapons, or aid to countries engaged in combat, MITI proscribes the export of particular military technologies. The Pentagon obviously finds this irksome.

Efforts to Improve the Two-Way Street

It is clear that some of these problems are more tractable than others. In light of the increased potential for trade frictions in the high technology

area, moves to enhance the exchange of technology are afoot in both the public and private sectors on both sides of the Pacific.

- U.S. participation in Japanese government research projects - Tokyo's financial support for the development of industrial technologies has generated repeated complaints from U.S. government and industry circles. A major source of criticism is that the Japanese subsidiaries of American companies are not eligible to participate in these projects, which some observers believe are the key to the international competitiveness of Japan's semiconductor and computer industries. This issue is one of the points raised by the Reagan administration during this year's intensive bilateral negotiations on electronics trade.

MITI representatives maintain that any company, foreign or domestic, can apply for government-funded R&D contracts. As proof, they cite the participation of several foreign firms in the Sigma project, a new five-year, ¥25 billion (\$122 million at ¥205=\$1.00) government-backed effort to develop an automated software production system. Moreover, DIC-Degremont Ltd., a partnership between France's Societe Lyon des Eaux and Dainippon Ink & Chemicals Inc., will join the Aquarenaissance 1990 project. This five-year program aims at developing a sewage treatment facility using bioreactors and ceramic filters that can turn sewage into drinking water and organic fuels such as methane.

Observers are still not convinced of MITI's commitment to foreign participation, however, citing strong pressure from the European Community and France to accept DIC-Degremont. To date, no American companies have won entry into a cutting-edge R&D program -- the Japanese cite a lack of U.S. interest, while Americans fault a dearth of Japanese information about upcoming projects. Nevertheless, the potential for significant cooperation is there.

- U.S. access to Japanese government patents - A related issue is foreign access to patents partly or wholly controlled by the Japanese government. MITI's Agency for Industrial Science and Technology, which has a say in licensing the patents that result from government-sponsored projects, has been reluctant to strike deals with interested foreign firms. IBM, however, recently gained the opportunity to inspect and license government-owned patents (see JEI Report No. 32B, August 23, 1985). This is a potentially important breakthrough, since it gives IBM access to ongoing and future AIST programs. It is unclear, however, if other companies will be granted similar privileges.

- Patent information via database - Patent offices in Japan, the United States and Europe are taking the first steps toward creating a single database covering patent applications. Although it is not envisioned that the various nations will unify their patent authorities, such a database will make cross-checking and international filing much more efficient.

- Congressional initiatives - The Hill has hopped on the bandwagon by passing a bill improving the information-gathering ability of the Commerce Department's National Technical Information Service. NTIS's mission is to evaluate not only domestic technologies but foreign ones as well. On November 23 the Senate approved an amendment to the Stevenson-Wydler Technology

Innovation Act of 1980 (S 1073) "for the purpose of improving the availability of Japanese science and engineering literature in the United States" (see JEI Report No. 46B, December 6, 1985). In previous hearings, NTIS officials had pointed out that their limited resources prevent them from translating more than a handful of technical treatises every year. If the Senate bill passes the House, it could give NTIS's efforts a big boost.

- Japanese publishing ventures and information services - In a parallel development, an information revolution of a different kind is taking place in Japan. Small companies that specialize in finding and translating Japanese technical and patent information are appearing with increasing frequency. In addition, many major Japanese newspapers and industry journals are beginning to offer foreign-language summaries of patents and research results. While the price may be high and the information of questionable veracity, it is still a big improvement over the void that existed in the past.

- Commercial efforts - Despite the daunting problems of penetrating Japan's research circles, American industry associations and individual companies persist in their efforts. Both the Electronic Industries Association and the American Electronics Association have information centers in Japan. Companies that cannot afford an outpost on their own are combining resources with other firms to establish a presence in Japan. Finally, major companies are founding research centers in Japan, hoping to attract input from academia as well as other businesses.

Additional steps are planned or contemplated to improve the bilateral situation. Japan's patent office is trying to automate its procedures to significantly reduce the processing time. Patent office officials discussing procedural reforms have also invited American and European businessmen to voice their opinions on how to simplify the process; these views will be incorporated in a report due out in July 1986. Moreover, DOD has been receiving so much flak from the American scientific community over its attempts to restrict the dissemination of information that greater discretion may be employed.

Conclusion

Japan has clearly benefited from its efforts to collect and adopt foreign technology. Characteristics such as a tradition of borrowing, a mentality devoted to "catching up" with foreigners, a highly educated population and strong government policies certainly have aided the assimilation of foreign know-how. Although other countries may not be able to duplicate all these factors, the key lesson is to avoid the "not-invented-here" syndrome -- the arrogant opinion that foreign technology is always inferior to what is available at home.

Japan's balance of technology trade has moved closer and closer to parity, due not only to transfers to industrial nations but also to a wide range of developing countries. In spite of this trend, the flow of U.S. technology to Japan will almost certainly remain greater than the reverse. Japan is clearly at the frontier of technology in several areas, yet because the infrastructure to promote the transfer of that technology to the United States remains underdeveloped, U.S. efforts are likely to be handicapped for some time.

Since this means that any rough spots will take years to smooth out, the United States and Japan will probably continue to experience problems. Despite the explosive nature of these problems, the potential for a major conflict over technology transfer is small. Both sides would rather prove that they can outrun the other in the technology race than try to hamper the other's progress. Joint public research projects, cooperative commercial R&D efforts and a freer exchange of research personnel will all help to dispel nagging fears.

For further information, contact Jon Choy.

* * * * *

The views expressed in this report are those of the author and do not necessarily represent those of the Japan Economic Institute.

JEI Report will not be published on December 27 or January 3 because of the Christmas and New Year's holidays. The next issue will appear January 10, 1986.

Appendix

Table 1: Japan's Corporate Technology Trade by Industry, FY 1980-FY 1983

(number of cases and value in millions yen)

a. FY 1980

	Exports				Imports			
	Total		New		Total		New	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	4,403	817,142	1,237	174,263	7,248	Y239,529	919	Y27,675
Agriculture	1	127	2	*	40	0	2,472	0
Mining	33	685	3	43	32	669	8	204
Construction	213	25,199	83	14,374	203	2,707	34	1,330
Manufacturing	3,947	811,274	1,140	49,798	6,839	233,185	857	25,773
Food Products	34	2,159	18	307	90	9,642	18	687
Textiles	82	8,159	17	289	161	2,233	28	170
Pulp and Paper	25	587	3	36	135	1,410	13	62
Publishing and Printing	14	136	2	*	45	968	3	*
Chemicals	1,917	36,879	201	6,767	840	38,232	120	3,403
Detergents	188	25,177	142	6,151	481	18,856	57	2,377
Fertilizers	44	1,987	28	181	122	2,951	9	210
Pharmaceuticals	382	6,988	26	273	132	10,182	26	600
Other	81	1,248	17	170	127	9,483	28	426
Petroleum	15	1,867	4	*	110	9,678	29	8,034
Rubber	36	1,228	1	47	128	5,942	8	53
Glass	200	2,084	58	4,700	152	9,612	25	921
Iron and steel	122	27,978	100	9,428	295	8,623	47	1,997
Nonferrous Metals	573	5,864	45	1,217	200	5,690	19	276
Metal Manufactures	7	1,122	18	438	225	4,440	15	108
NonElectric Machinery	159	8,623	238	8,280	1,812	30,278	118	1,980
Electric Machinery	781	27,041	126	8,440	1,511	81,678	254	4,959
Machine Tools	109	2,907	45	579	580	21,778	46	1,532
Electronics	817	27,078	108	1,681	1,121	59,899	108	3,427
Transportation Equipment	100	1,758	88	11,819	941	40,274	87	1,832
Automotive	283	8,442	22	581	238	10,363	40	540
Other	716	13,136	66	11,238	703	29,911	47	1,291
Precision Machinery	52	871	14	82	236	4,948	27	269
Other	880	6,472	153	1,751	231	1,187	46	1,020
Transportation, Communications	15	122	7	119	174	496	20	368

b. FY 1981

	Total		New		Total		New	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	4,267	177,306	1,017	878,763	7,097	Y219,832	844	Y24,911
Agriculture	13	419	8	275	3	*	1	*
Mining	14	411	2	180	51	661	4	*
Construction	24	2,940	24	27,800	264	2,918	37	1,657
Manufacturing	4,196	171,786	1,015	26,484	6,878	253,606	792	23,081
Food Products	113	5,084	82	1,305	119	10,609	25	1,007
Textiles	299	8,923	27	717	448	8,722	14	136
Pulp and Paper	50	12,982	30	363	46	1,342	4	*
Publishing and Printing	17	485	2	107	46	993	5	26
Chemicals	1,941	31,921	147	8,382	768	37,110	101	3,537
Detergents	168	18,878	94	6,439	430	14,754	39	1,983
Fertilizers	114	22,073	17	174	141	2,522	20	342
Pharmaceuticals	351	1,877	30	1,057	187	11,087	23	992
Other	108	2,095	13	124	88	8,779	19	220
Petroleum	714	8,413	148	9,584	48	3,037	9	422
Rubber	36	1,580	8	158	113	3,245	8	43
Glass	201	8,817	50	1,997	141	10,137	18	949
Iron and steel	187	24,541	131	11,059	317	14,808	51	7,668
Nonferrous Metals	150	2,337	55	917	175	5,623	16	184
Metal Manufactures	59	914	11	72	140	2,816	10	113
NonElectric Machinery	105	1,330	108	868	1,067	30,810	127	1,585
Electric Machinery	879	28,860	107	4,519	1,847	68,814	254	3,961
Machine Tools	141	8,385	122	1,721	480	25,062	124	698
Electronics	158	18,081	75	2,594	1,367	43,752	130	3,263
Transportation Equipment	172	20,019	80	10,995	949	48,674	87	2,719
Automotive	172	14,788	26	1,404	275	10,455	35	386
Other	147	17,811	54	9,591	674	38,219	52	2,333
Precision Machinery	80	2,900	18	914	247	3,759	37	344
Other	383	6,484	146	823	306	6,996	26	381
Transportation, Communications	10	82	6	59	58	458	10	131

Table 1 - continued

c. FY 1982

	Exports				Imports			
	Total		New		Total		New	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	4,738	¥184,921	1,970	¥63,336	6,936	¥282,613	929	¥44,439
Agriculture	0	320	2	*	0	0	0	0
Mining	10	821	0	49	29	193	11	92
Construction	384	19,443	353	17,833	177	2,198	38	213
Manufacturing	4,302	184,058	1,599	45,159	6,692	278,075	841	42,475
Food Products	482	4,729	426	1,962	84	11,286	17	1,168
Textiles	71	6,253	21	540	294	2,821	81	293
Pulp and Paper	82	1,158	92	444	184	1,220	18	153
Publishing and Printing	17	81	4	*	48	1,066	6	22
Chemicals	815	28,408	202	7,916	795	45,860	94	8,984
Textiles	424	18,004	183	8,234	459	22,807	48	7,948
Fertilizers	182	2,280	11	150	132	2,478	20	104
Plastics and allied	108	16,808	78	787	118	13,009	16	830
Other	77	2,444	19	777	84	7,566	10	102
Electronics	19	578	11	617	75	2,909	11	639
Automotive	16	2,184	8	49	119	3,475	10	219
Glass	191	2,271	75	1,689	182	10,759	20	704
Iron and Steel	442	20,547	274	9,983	523	7,800	28	934
Nonferrous Metals	151	1,034	45	1,781	171	3,396	18	344
Metal Manufactures	278	4,894	59	1,442	400	3,057	8	45
Nonmetallic Minerals	318	7,443	212	1,718	967	27,403	101	1,717
Glasses, Mirrors	101	11,444	87	4,682	1,825	89,151	247	15,530
Machine Tools	111	6,201	50	498	403	28,681	38	8,611
Electronics	59	2,475	200	1,381	1,110	38,475	209	10,919
Transportation Equipment	19	26,540	7	9,140	907	56,415	75	8,872
Automotive	194	11,499	47	888	492	16,094	25	4,702
Other	186	18,401	42	8,144	914	40,319	48	4,170
Transportation Machinery	40	2,818	48	504	188	3,585	39	1,247
Other	154	7,681	118	1,250	314	7,458	90	1,623
Transportation, Communications	27	573	10	211	58	1,948	9	1,600

(1) FY 1981

Total	4,738	¥184,921	1,970	¥63,336	6,936	¥282,613	929	¥44,439
Agriculture	0	320	2	*	0	0	0	0
Mining	10	821	0	49	29	193	11	92
Construction	384	19,443	353	17,833	177	2,198	38	213
Manufacturing	4,302	184,058	1,599	45,159	6,692	278,075	841	42,475
Food Products	482	4,729	426	1,962	84	11,286	17	1,168
Textiles	71	6,253	21	540	294	2,821	81	293
Pulp and Paper	82	1,158	92	444	184	1,220	18	153
Publishing and Printing	17	81	4	*	48	1,066	6	22
Chemicals	815	28,408	202	7,916	795	45,860	94	8,984
Textiles	424	18,004	183	8,234	459	22,807	48	7,948
Fertilizers	182	2,280	11	150	132	2,478	20	104
Plastics and allied	108	16,808	78	787	118	13,009	16	830
Other	77	2,444	19	777	84	7,566	10	102
Electronics	19	578	11	617	75	2,909	11	639
Automotive	16	2,184	8	49	119	3,475	10	219
Glass	191	2,271	75	1,689	182	10,759	20	704
Iron and Steel	442	20,547	274	9,983	523	7,800	28	934
Nonferrous Metals	151	1,034	45	1,781	171	3,396	18	344
Metal Manufactures	278	4,894	59	1,442	400	3,057	8	45
Nonmetallic Minerals	318	7,443	212	1,718	967	27,403	101	1,717
Glasses, Mirrors	101	11,444	87	4,682	1,825	89,151	247	15,530
Machine Tools	111	6,201	50	498	403	28,681	38	8,611
Electronics	59	2,475	200	1,381	1,110	38,475	209	10,919
Transportation Equipment	19	26,540	7	9,140	907	56,415	75	8,872
Automotive	194	11,499	47	888	492	16,094	25	4,702
Other	186	18,401	42	8,144	914	40,319	48	4,170
Transportation Machinery	40	2,818	48	504	188	3,585	39	1,247
Other	154	7,681	118	1,250	314	7,458	90	1,623
Transportation, Communications	27	573	10	211	58	1,948	9	1,600

*Less than 1 million.

Source: Prime Minister's Office, Report on the Survey of Research and Development

Table 2: Japan's Corporate Technology Trade by Country, FY 1980-FY 1983

(number of cases and value in billions of yen)

a. Exports

	FY 1980		FY 1981		FY 1982		FY 1983	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Asia	2,862	¥83.8	2,761	¥78.1	2,470	¥111.6	3,084	¥119.2
China	77	9.5	71	4.8	101	4.5	236	18.4
Taiwan	570	9.9	779	12.0	447	9.7	655	10.8
Korea	516	5.3	621	9.5	485	7.5	903	17.0
Thailand	155	4.2	154	5.0	229	5.6	287	6.1
Philippines	108	3.5	90	1.4	127	2.3	131	13.5
Indonesia	383	7.6	165	10.8	227	14.8	273	15.8
North America	800	29.5	789	38.3	784	40.8	1,226	60.0
United States	652	22.1	650	32.6	654	35.6	1,069	53.6
South America	196	19.8	218	11.8	220	10.8	238	10.1
Brazil	95	9.3	107	7.4	110	7.3	133	7.9
Europe	736	29.0	834	32.1	835	39.0	1,597	37.1
Great Britain	99	2.1	119	2.6	118	8.4	469	5.3
West Germany	145	3.4	179	2.9	152	4.7	431	5.1
France	106	2.3	112	4.5	121	3.9	144	4.5
Holland	22	0.7	21	1.2	31	1.0	46	2.4
Switzerland	56	0.5	44	1.6	58	2.1	52	2.1
Africa	129	8.4	146	9.6	314	12.4	137	9.2
Oceania	99	3.2	129	3.2	115	5.5	121	5.3

b. Imports

	FY 1980		FY 1981		FY 1982		FY 1983	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Asia	11	¥0.2	153	0.9	171	0.7	10	0.2
China	0	0	2	0.1	1	*	3	*
Taiwan	2	*	4	*	1	*	2	*
Korea	2	*	42	0.3	41	0.5	1	*
North America	1,267	156.9	4,189	173.9	4,158	188.6	4,757	194.0
United States	4,162	153.8	4,092	171.8	4,062	187.0	4,698	191.1
South America	1	*	2	*	1	*	3	*
Europe	2,931	82.1	2,821	84.4	2,618	92.7	5,025	84.5
West Germany	826	20.5	856	18.9	803	17.8	832	19.6
Britain	700	20.2	586	18.0	462	25.0	480	147
France	421	11.1	334	10.5	333	10.9	401	11.4
Switzerland	428	15.9	265	15.4	326	15.7	335	15.9
Holland	111	6.5	185	10.0	150	12.7	151	11.3
Africa	3	*	4	*	5	0.3	4	*
Oceania	35	0.3	38	0.3	43	0.4	40	0.4

*Less than ¥1 billion

Source: Office of the Prime Minister, Report on the Survey of Research and Development

Table 3: Japan's Corporate Technology Trade By Industry By Region, FY 1980-FY 1983

(number of cases and value in millions of yen)

a. FY 1980

	Exports								Imports			
	Asia		North America		South America		Europe		North America		Europe	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	1,145	178,631	800	129,501	196	118,842	736	129,046	4,267	1156,862	2,931	182,127
Agriculture	2	*	0	0	2	*	0	0	20	1,772	20	700
Mining	0	99	8	324	2	*	2	*	9	168	23	502
Construction	78	23,316	14	583	8	935	6	112	59	1,475	141	1,201
Manufacturing	1,067	155,006	769	128,587	183	9,089	725	128,696	4,154	153,056	2,738	79,619
Food Products	33	1,411	12	46	6	248	15	453	54	2,572	36	7,070
Textiles	43	2,001	11	221	0	0	18	723	91	781	69	1,328
Pulp and Paper	8	173	7	135	0	0	9	235	72	1,187	31	223
Publishing	2	*	7	*	0	0	6	82	26	934	16	24
Chemicals	434	12,217	168	7,638	19	1,321	213	9,698	463	22,478	373	16,726
Textiles	332	10,598	103	3,688	13	1,233	110	7,003	261	10,397	197	6,210
Fertilizers	244	909	17	741	0	0	13	248	75	2,455	44	495
Pharmaceuticals	50	457	41	948	7	31	68	1,512	60	4,308	72	5,854
Other	58	362	7	261	1	*	12	935	67	5,317	60	4,166
Petroleum	8	769	2	*	0	0	3	*	74	8,972	36	706
Rubber	27	1,137	0	0	0	0	5	17	74	2,584	54	1,357
Glass	64	3,084	22	463	3	49	30	3,122	84	3,768	68	5,844
Iron and Steel	75	2,913	60	8,435	47	3,356	102	4,310	136	5,701	155	2,292
Nonferrous Metals	51	535	21	598	17	159	26	501	121	2,203	74	1,440
Metal Manufactures	51	898	0	10	2	*	6	37	116	2,534	100	1,877
Non-electric Machinery	299	5,291	35	2,342	11	587	67	1,077	860	21,495	750	8,712
Electric Machinery	287	11,221	259	7,192	53	980	83	2,391	1,195	46,804	302	14,834
Machine Tools	184	4,619	64	1,211	18	634	37	1,221	275	16,903	114	4,873
Electronics	201	8,771	90	3,981	27	327	46	1,371	920	29,901	188	9,961
Transportation												
Equipment	377	8,865	46	1,917	22	491	87	956	513	25,506	425	14,734
Automotive	109	5,070	14	532	5	44	17	187	145	6,351	111	3,978
Other	268	4,795	28	1,385	17	449	70	4,769	368	19,154	314	10,756
Precision Machinery	18	62	182	3,746	1	*	19	451	140	2,213	93	687
Other	151	1,969	181	3,746	0	0	36	307	135	3,324	156	1,763
Transportation, Communications	1	*	3	*	1	*	1	*	25	391	9	105

b. FY 1981

Total	1,761	178,661	784	146,126	218	113,770	834	152,149	4,189	1178,901	2,821	184,425
Agriculture	2	316	0	0	2	*	0	0	0	0	0	0
Mining	0	180	0	248	0	0	1	*	9	103	22	558
Construction	144	18,703	5	*	16	1,072	14	3,141	51	854	212	2,063
Manufacturing	1,615	158,480	779	145,076	202	9,698	813	18,992	4,099	172,618	2,579	81,693
Food Products	46	2,261	7	553	4	*	13	552	75	4,114	40	6,464
Textiles	254	8,276	7	506	0	0	11	782	222	3,987	276	4,735
Pulp and Paper	7	18	275	9	369	1	*	8	231	60	1,202	16,139
Publishing	2	12	3	*	0	0	7	117	29	950	14	31
Chemicals	213	8,485	177	10,136	27	860	253	11,341	436	21,452	324	15,546
Textiles	184	8,443	110	4,509	14	844	132	59692	243	9,371	184	5,344
Fertilizers	70	1,612	19	753	0	0	22	800	82	1,898	57	611
Pharmaceuticals	14	435	30	4,796	8	58	79	2,955	49	4,006	57	6,990
Other	25	62	7	234	2	*	20	2,594	62	6,178	26	2,601
Petroleum	140	3,908	1	*	2	*	1	*	62	1,599	35	1,422
Rubber	22	1,271	7	16	0	0	7	591	69	1,940	44	1,305
Glass	91	2,224	29	1,027	4	*	34	1,189	83	4,095	56	6,110
Iron and Steel	86	12,758	154	6,532	69	3,730	142	6,471	154	11,927	159	2,818
Nonferrous Metals	74	526	25	737	2	288	29	459	108	2,122	62	1,455
Metal Manufactures	41	476	5	57	1	*	6	5	94	2,046	43	758
Non-electric Machinery	280	2,604	48	2,144	8	203	34	263	543	23,224	524	7,586
Electric Machinery	406	13,698	234	6,545	55	1,724	110	2,564	1,390	52,219	339	16,353
Machine Tools	211	6,718	127	2,583	23	501	32	753	252	18,755	126	6,150
Electronics	193	7,981	107	6,962	32	724	58	1,811	1,138	33,464	311	10,860
Transportation												
Equipment	172	13,848	39	8,181	24	903	90	3,046	504	33,728	440	14,918
Automotive	109	7,271	13	539	8	60	15	721	142	6,769	129	4,058
Other	63	6,635	26	2,642	16	842	75	2,325	362	26,959	311	10,860
Precision Machinery	57	1,489	16	387	2	*	20	826	169	2,807	75	947
Other	341	1,472	35	4,411	0	0	45	356	131	5,205	132	1,105
Transportation, Communications	1	*	10	10	2	*	4	*	30	326	8	111

Table 3 - continued

c. FY 1982

	Exports						Imports					
	Asia		North America		South America		Europe		North America		Europe	
	Cases	Value	Cases	Value	Cases	Value	Cases	Value	Cases	Value	Cases	Value
Total	2,470	¥77,464	784	¥40,819	220	¥10,803	835	¥38,963	4,058	¥188,561	2,618	¥92,662
Agriculture	3	*	0	0	2	*	0	0	0	0	0	0
Mining	7	198	5	255	0	0	3	*	10	150	18	140
Construction	207	14,705	6	6	8	66	8	141	86	913	90	1,384
Manufacturing	2,245	60,917	763	40,444	209	10,725	816	38,331	4,033	185,705	2,501	90,985
Food Products	450	3,505	9	280	3	249	16	682	50	4,970	32	6,311
Textiles	46	1,788	8	344	0	0	16	3,752	122	705	107	1,967
Pulp and Paper	62	585	9	323	1	*	7	201	127	1,030	37	190
Publishing	5	14	4	*	0	0	6	38	28	991	17	22
Chemicals	299	8,780	218	9,141	28	1,076	256	9,465	427	27,276	361	18,225
Textiles	142	5,962	136	4,393	20	1,007	115	5,135	260	16,647	195	6,131
Fertilizers	87	1,063	18	914	0	0	23	295	72	1,802	60	677
Pharmaceuticals	36	433	31	3,452	6	31	101	2,693	49	4032	68	8,647
Other	40	647	9	382	2	*	17	1,341	46	4,795	38	2,771
Petroleum	11	100	0	0	3	*	1	*	50	1,149	25	1,760
Rubber	23	1,525	7	70	0	0	7	304	71	1,872	48	1,601
Glass	89	4,762	23	487	14	154	33	700	69	4,448	72	6,282
Iron and Steel	105	6,294	87	4,627	31	6,496	155	9,082	142	5,003	177	2,754
Nonferrous Metals	78	1,579	30	349	6	306	33	191	105	2,154	63	1,193
Metal Manufactures	39	1,326	18	128	1	*	6	48	148	2,144	31	909
Nonelectric Machinery	182	2,247	48	2,171	8	130	45	574	319	20,426	404	6,920
Electric Machinery	114	79,171	186	10,473	57	933	97	8,380	1,414	62,005	398	27,064
Machine Tools	210	5,879	65	2,497	27	317	28	712	260	21,970	137	7,702
Electronics	304	8,278	123	7,936	30	415	69	7,869	1,154	40,035	261	19,365
Transportation												
Equipment	170	11,611	50	6,147	30	1,013	93	3,236	492	43,316	411	13,059
Automotive	115	8,254	15	1,093	13	57	20	2,189	143	12,253	115	3,804
Other	35	2,789	35	6,053	17	958	73	1,047	349	31,064	296	9,255
Precision Machinery	35	1,038	26	403	3	*	18	848	114	2,859	71	639
Other	137	1,326	30	5,333	2	*	27	553	153	3,558	227	2,080
Transportation, Communications	8	386	18	64	1	*	8	328	29	1,792	9	154

d. FY 1983

Total	3,684	¥119,220	1,226	¥60,034	238	¥10,068	1,387	¥57,055	4,757	¥194,000	3,025	¥84,499
Agriculture	5	269	0	0	2	*	0	0	0	0	0	0
Mining	7	387	2	*	1	*	0	0	4	*	10	54
Construction	157	21,339	63	2,517	3	*	15	460	339	3,698	104	698
Manufacturing	2,730	95,046	1,160	57,408	236	9,997	1,376	56,538	4,401	188,317	2,909	83,746
Food Products	91	1,787	10	805	4	*	19	812	38	2,237	28	6,424
Textiles	36	1,418	16	371	0	0	8	351	104	1,027	170	4,516
Pulp and Paper	14	412	12	408	1	*	8	258	25	561	14	85
Publishing	5	*	2	*	1	*	4	*	25	863	12	26
Chemicals	372	9,078	198	10,754	30	653	273	10,188	562	26,188	353	15,876
Textiles	159	6,727	106	3,568	20	313	13	5,586	251	13,535	197	4,036
Fertilizers	102	1,126	23	856	1	*	18	73	84	2,324	61	1,289
Pharmaceuticals	33	343	36	8,131	7	16	116	6,410	136	5,401	85	6,752
Other	78	812	8	179	2	*	24	1,119	71	4,927	30	3,800
Petroleum	11	118	1	*	2	*	3	168	41	1,016	29	1,674
Rubber	20	3,386	9	533	0	0	9	17	80	2,342	56	1,620
Glass	100	6,307	40	1,046	7	70	116	1,377	78	3,789	391	2,937
Iron and Steel	93	14,967	86	3,789	31	6,300	130	11,550	130	13,645	166	3,881
Nonferrous Metals	71	1,688	23	174	7	178	30	141	129	2,737	49	900
Metal Manufactures	68	1,031	21	123	2	*	7	91	94	1,555	73	1,043
Nonelectric Machinery	345	6,277	290	2,352	47	872	95	4,942	735	18,706	538	9,779
Electric Machinery	754	17,959	241	11,572	59	599	144	4,345	1,515	72,149	374	19,721
Machine Tools	230	7,122	91	2,892	37	424	48	947	249	20,166	127	7,560
Electronics	323	10,837	110	8,679	22	177	96	3,598	1,266	51,984	247	12,160
Transportation												
Equipment	209	10,916	61	7,774	28	630	96	4,109	491	44,440	366	12,399
Automotive	139	8,223	22	5,904	15	197	24	1,888	147	6,543	107	4,071
Other	70	2,717	39	3,869	13	432	72	2,221	344	27,897	259	8,328
Precision Machinery	113	3,957	13	414	4	*	21	534	196	3,330	118	758
Other	231	16,141	132	17,260	6	62	110	1,853	162	3,534	172	2,108
Transportation, Communications	5	*	11	152	2	*	6	55	9	1,832	2	*

*Less than ¥1 million

Source: Prime Minister's Office, Report on the Survey of Research and Development